



Original Article

Behavioral Pain Indicators in Patients with Traumatic Brain Injury Admitted to an Intensive Care Unit

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ABSTRACT

Introduction: A consistent approach to pain assessment for patients admitted to intensive care unit (ICU) is a major difficulty for health practitioners due to some patients' inability, to express their pain verbally. This study aimed to assess pain behaviors (PBs) in traumatic brain injury (TBI) patients at different levels of consciousness.

Methods: This study used a repeated-measure, within-subject design with 35 patients admitted to an ICU. The data were collected through observations of nociceptive and non-nociceptive procedures, which were recorded through a 47-item behavior-rating checklist. The analyses were performed by SPSS ver.13 software.

Results: The most frequently observed PBs during nociceptive procedures were facial expression levator contractions (65.7%), sudden eye openings (34.3%), frowning (31.4%), lip changes (31.4%), clear movement of extremities (57.1%), neck stiffness (42.9%), sighing (31.4%), and moaning (31.4%). The number of PBs exhibited by participants during nociceptive procedures was significantly higher than those observed before and 15 minutes after the procedures. Also, the number of exhibited PBs in patients during nociceptive procedures was significantly greater than that of exhibited PBs during the non-nociceptive procedure. The results showed a significant difference between different levels of consciousness and also between the numbers of exhibited PBs in participants with different levels of traumatic brain injury severity.

Conclusion: The present study showed that most of the behaviors that have been observed during painful stimulation in patients with traumatic brain injury included facial expressions, sudden eye opening, frowning, lip changes, clear movements of extremities, neck stiffness, and sighing or moaning.

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Introduction

Physical pain is an unpleasant feeling caused by an actual or potential tissue damage created by the release of inflammatory mediators.¹ The experience of pain may be influenced by several factors such as emotional state, previous experiences, cognitive functioning, and age and it is generally agreed that the best instrument for detecting pain and its characteristics is the patients themselves.² Complications associated with pain include increased catabolism time, immune suppression, increased heart rate, increased oxygen consumption, blood pressure changes, decreased perfusion rate, increased sodium retention and urine sugar, and insulin resistance.^{3,4} Moreover, stress, depression, anxiety and delirium are examples of psychological components of pain.⁵ The effective assessment and management of pain is a major public health concern throughout the world with implications for social, economic, and clinical contexts.⁶ Pain is strongly and positively associated with increased mortality rate and quality of life,⁵ therefore an effective pain management may have tangible social and

economic benefits, such as a decrease in time spent in hospitals, and consequently, reduced healthcare costs. From a clinical perspective, the American Pain Society (APS) considers pain to be the fifth vital sign.⁷ Therefore, a greater understanding of pain has implications for improved patient care.

Pain is a commonly reported problem in Intensive Care Units (ICU)^{4,8,9} associated with negative experiences of the patients during hospitalization.¹⁰ Researchers have stated that approximately 50 percent of ICU patients report moderate to severe pain during routine procedures,^{9,11} which may be due to events such as surgery, trauma or invasive procedures.⁵ Improving pain management, not only leads to better patient care and assessment,^{4,9} but also to the reduction of analgesics in ICU.⁹ Effective assessment of pain can shorten the duration of mechanical ventilation and reduce the associated side effects;^{9,12} however, despite the reported benefits, the assessment of pain in critically ill adults remains a daily clinical challenge for most health professionals working in an ICU.¹³

Although an individual patient's self-reported pain is the gold standard measure for pain,¹³ the assessment of pain through self-report measures in an ICU have limitations.^{8,14} A patient's situation at ICU (e.g., critical illness, mechanical ventilation, use of analgesics or sedatives, and level of consciousness) can limit their ability to communicate⁵ and the need for emergency procedures or treatment may overshadow the need to properly assess patient pain. In an ICU setting, high levels of pain, may remain uncontrolled due to improper pain evaluation.⁸ When self-reported measures of pain are not possible, observational pain scales are recommended for clinical use in adults in critical conditions.¹³ Using objective measures, such as the Behavioral Pain Scale (BPS), is a widely practiced strategy.^{15,16} Nonverbal expressions such as facial expressions, body movements, muscle tensions, and successful adaptation to ventilation⁹ are among the behaviors that doctors consider to be valid indicators of pain severity.¹⁴ These nonverbal expressions may compliment a patients' verbal reports of pain.¹⁷ A nurse's awareness of nonverbal cues related to pain expression may assist them to make effective decisions regarding pain control.¹⁸

Research has revealed that formal pain assessment is not routinely conducted on all patients admitted to ICU. For example, Bucknall *et al.*, reported that pain assessment was only conducted in 4.4% of cases.¹⁹ A lack of understanding of a patient's pain may result in a failure to meet the patient's needs.²⁰ Moreover, it may limit the effectiveness of pharmacological and non-pharmacological interventions.^{21, 22}

Very few studies have focused on the assessment of pain in hospitalized patients in ICU.^{2,22,23} These studies have reported the limitations of self-reported assessments of pain in an ICU setting.⁸ There is also a lack of understanding about typical and atypical behaviors associated with pain,²³ making pain assessment a complex, yet necessary undertaking. The pain management of hospitalized patients who are unable to communicate their pain, as is the case with the unconscious patients, is particularly important. More accurate ways to assess pain in patients, especially for those with a Traumatic Brain Injury (TBI), will enable nurses to improve the quality of care and reduce negative long-term physiological and psychological consequences associated with inadequate pain management.²⁴ This study aimed to assess pain behaviors (PBs) in patients with a TBI experiencing different levels of consciousness.

Materials and methods

A repeated-measure, within-subject design was used for the present study. A convenience sampling method was used to recruit patient admitted to the ICU trauma ward of the 17 Shahrvivar Hospital in Amol, Iran (February–November 2016). A total of 35 patients were approached to participate in the study. The results of performing a power analysis, using G-power 3.0.10 software, taking an effect size of 0.540 (based on a similar study outcome),²⁵ $\alpha = 0.05$, power $(1-\beta) = 0.80$ showed that the sample size is

big enough for the present study. The inclusion criteria determined that participants needed to 1) be 18 years or older; 2) have been admitted to the ICU following a TBI, (at least 24 hours prior with or without other trauma); 3) be hospitalized for less than one month after a TBI in the ICU; and 4) have not received sedation or drugs in the past four hours. Participants were excluded if they had a Glasgow Coma Scale (GCS) score of three, movement limitations (e.g. motor paralysis, spinal cord injury, and nerve block effect), or a history of chronic drug use, head trauma, a diagnosed psychiatric disorder, or suspected brain death.

Each patient was regarded as his/her own control group to be observed during two routine procedures: (1) Non-invasive blood pressure measurement (known as a non-nociceptive procedure and providing the control group); (2) Compression of the medial nail bed during the GCS examination (known as a nociceptive procedure and providing the intervention group). The non-nociceptive and nociceptive procedures were chosen, because they are both routine procedures in the ICU without any additional cost to the patient and therefore they do not impose any additional pain on the patient. The participants were observed for 1 minute before (baseline), during, and 15 minutes after the two procedures. Each patient was evaluated six times. The observations were documented using the behavior checklist.

The Behavior Checklist included 47 behavior-based items related to pain. These items were derived from two validated scales of pain assessment in ICUs.^{15,25} The questions were classified into four categories: (1) facial expressions, (2) body movements, (3) muscle tension or stiffness, and (4) compliance with the ventilator for intubated patients, or verbal pain expression for non-intubated patients. The participants were required to respond with 'yes' or 'no', indicating whether or not a particular behavior had been experienced. The demographic characteristics of all patient participants were also recorded. The behaviors related to a resting state and the presence of neutral muscle activity (e.g. a relaxed face, eyes closed, and absence of body movement) were considered as "neutral behaviors".

Conversely, behaviors that could be perceived as a reaction to a nociceptive procedure (e.g., grimacing or physically guarding pain site, for instance) were considered as "pain behaviors". All the observations were conducted for a three-hour period from 9 A.M to 12 Midday in order to replicate environmental conditions in terms of light and sound. The researchers' strategy to control the confounding factors was to place each patient as his/her own control.

Level of consciousness was assessed using the GCS, which divides patients into three categories: 1) non-conscious (GCS ≤ 8); 2) semi-conscious (GCS = 9-12); and 3) conscious (GCS ≥ 13) (23). An adapted GCS was used for the intubated patients.

Types of head injuries and damages were recorded according to neurologist reports based on brain CT scans.

To minimize error in patient observations a video recording was used. Thus, two cameras were used for

data collection, one placed at the bottom of the bed to record the patient's body movements, and the other positioned on the top of the bed focused on the patient's face. Two trained researchers reviewed the recordings independently and completed the behavior checklists immediately after each procedure. Correct positioning of the cameras was ensured prior to recording. The completed behavior checklists were compared to assess agreement and reliability. Cohen's kappa was used to determine if there was an agreement between the observers' ratings of patient behavior. The findings revealed a good level of agreement, $K = 0.767$. During the initial observation, the health professionals found that some camera angles were not suitable to accurately record more subtle and nuanced behaviors (e.g. the patient's face flushing). To solve this problem, the observers who were present at the patients' bedsides were asked to make a note of such physical responses.

Descriptive statistics were used to report the most frequently observed PBs during the nociceptive procedure. Shapiro-Wilk tests were conducted to assess the distribution of data for normality. Then, PBs were compared across different assessment periods (i.e., before, during, and after), different levels of consciousness (LOC), different levels of TBI severity, and different TBI locations, using a one-way ANOVA and Fisher's least significant difference (LSD) with Bonferroni correction as the post hoc analysis, if the data was normal. Where the data deviated from the normal distribution, the Friedman test with Wilcoxon signed ranks tests as the post hoc analysis was performed. The analyses were performed using SPSS ver.13 software (SPSS Inc., Chicago, IL USA). All tests were two-tailed and a P-value less than 0.05 was considered as significant.

This study was conducted in accordance with the conventions of the Helsinki Statement (Association GAotWM, 2014) and was approved by Mazandaran University of Medical Sciences Ethics Committee (Code IR.MAZUMS.REC1396.2934). Hospital, patients and their families were informed about the study's aims and procedures and assured that verbal and behavioral responses would be kept confidential. Blood pressure measurements using non-invasive procedures and observations of the patient's level of consciousness was carried out every two hours. No additional pain was imposed on the patient. There were no costs associated with participating in the study.

Results

Table 1 shows the participant's characteristics. The participants' age ranged from 18 to 83 ($M=41.49$, $SD=51.17$). Of these participants, 31 (88.6%) were male and 4 (11.4%) were female. Road traffic accidents, where the patient was a passenger in a vehicle, was the main cause of TBI ($n = 17$, 48.6%) followed by road traffic accidents where the patient was a pedestrian ($n= 11$, 31.4%), and where the patient had experienced a fall ($n= 7$, 20.0%). Most of the patients had been admitted to hospital for more than one week. Using Shapiro-Wilk

tests, the distribution of the PB data during a nociceptive procedure did not deviate significantly from normal distribution. However, the distribution of the PB data during a non-nociceptive procedure was not found to be normally distributed.

Table 1. Participants' characteristics

Characteristics	N (%)
Gender	
Man	31(88.6)
Woman	4(11.4)
TBI cause	
Fall	7(20)
Accident (passenger)	17(48.6)
Accident (pedestrian)	11(31.4)
TBI severity	
Mild	12(34.3)
Moderate	12(34.3)
Sever	11(31.4)
Breathing	
Mechanical ventilation	16(45.7)
Intubated without mechanical ventilation	1(2.9)
Not Intubated	18(51.4)
Age*	41.49 (18.70)

*Mean (SD)

Table 2 reports the results of pairwise comparisons of PBs observed in participants before, during, and after non-nociceptive and nociceptive procedures. The results of performing Friedman tests ($\chi^2(5) = 128.069$, $P < 0.001$) followed by post hoc analyses, using Wilcoxon signed ranks tests indicated that the number of PBs exhibited by participants during a nociceptive procedure was significantly higher than that before the procedure ($Z = -4.871$, $P < 0.001$) and 15 minutes after ($Z = -4.794$, $P < 0.001$).

However, no significant difference was observed between the scores before or after the procedure ($Z = -0.816$, $P = 0.414$). Moreover, the number of PBs exhibited by the participants during a non-nociceptive procedure was significantly higher than that before the procedure ($Z = -4.055$, $P < 0.001$) and 15 minutes after ($Z = -4.050$, $P < 0.001$). There was no significant difference between before and after the non-nociceptive procedure ($Z = 0.000$, $P = 1.000$). The results also showed that the number of PBs exhibited in patients during the nociceptive procedure was significantly greater than the number of PBs exhibited during the non-nociceptive procedure at 95% confidence interval level ($Z = -4.870$, $P < 0.0001$). The PBs most frequently observed during the nociceptive procedure were facial expressions that included: levator contraction (65.7%), sudden eye opening (34.3%), frowning (31.4%), lip changes (31.4%), clear movement of extremities (57.1%), neck stiffness (42.9%), sighing (31.4%), and moaning (31.4%).

A one-way between subjects ANOVA was conducted to compare PBs exhibited by participants with different LOC. The results, reported in Table 3, showed a significant difference between the three levels of consciousness at 95% confidence level, $F(2, 32) = 13.139$, $P < 0.001$. The results of a post hoc test, using Fisher's least significant difference (LSD) with Bonferroni correction are reported in Table 3. The results revealed that conscious patients ($M=8.36$, $SD=3.20$) exhibited significantly different PBs than unconscious patients (M

Table 2. Pairwise comparisons of PBs observed in participants before, during, and after non-nociceptive and nociceptive procedures (N = 35)

Procedure	Mean (SD)	Percentiles			P- value
		25 th	50 th	75 th	
[1] Before the nociceptive procedure	0.20(0.47)	0	0	0	[2] – [1], P < 0.001; [3] – [1], P = 0.41
[2] During the nociceptive procedure	5.74(3.64)	4	6	9	[3] – [2], P < 0.001; [5] – [4], P < 0.001
[3] After the nociceptive procedure	0.14(0.35)	0	0	0	[6] – [5], P < 0.001; [6] – [5], P = 1.00
[4] Before the non-nociceptive procedure	0.11(0.40)	0	0	0	[4] – [1], P = 0.25; [5] – [2], P < 0.001
[5] During the non-nociceptive procedure	1.45(1.44)	0	1	3	[6] – [3], P = 0.56
[6] After the non-nociceptive procedure	0.11(0.40)	0	0	0	

= 2.33, SD= 3.32, P<0.001), and altered patients (M= 5.25, SD= 1.54, P<0.05). However, this study could not find any significant differences between unconscious and altered patients (P=0.071).

The most commonly observed PBs in patients with mild TBI included clear limb shaking (91.7%), turned cheek (70%), groaning (66.7%), and rapid eye opening (58.3%). In patients with moderate TBI, most behaviors relating to the pain were turn cheek (83.3%), clear limb shaking (58.3%), groaning (33.3%), limited movement of limbs (33.3%), and rapid eye opening (33.3%). Although the number of pain behaviors observed in the group with severe TBI was less than the previous two groups, the most frequent of these behaviors included turn cheek (36.4%), limited movement of limbs (36.4%), frowning (27.3%) and neck stiffness (27.3%).

Table 3. Number of Pain Behaviors across different levels of consciousness, TBI severity, and TBI location of the participants (N = 35)

Variable	N (%)	Mean (SD)	Bonferroni adjusted P
LOC			F(2, 32) = 13.13, P < 0.01
[1] Unconscious	9 (25.7)	2.33 (3.31)	[1] – [2] (P = 0.07)
[2] Altered	12 (34.3)	5.25 (1.54)	[1] – [3] (P < 0.01)
[3] Conscious	14 (40.0)	8.35 (3.20)	[2] – [3] (P < 0.01)
TBI Severity			F(2, 32) = 7.565, P < 0.01
[1] Mild	12 (34.3)	8.00 (2.73)	[1] – [2] (P = 0.36)
[2] Moderate	12 (34.3)	6.00 (3.30)	[1] – [3] (P < 0.01)
[3] Severe	11 (31.4)	3.00 (3.22)	[2] – [3] (P = 0.08)
TBI Location			F(7, 27) = 0.58, P = 0.76
[1] Frontal	11 (31.4)	5.36 (4.20)	n.a.
[2] Temporal	4 (11.4)	4.25 (1.50)	
[3] Frontotemporal	2 (5.7)	7.00 (1.41)	
[4] Temporoparietal	5 (14.3)	7.60 (3.78)	
[5] Occipital	6 (17.1)	6.33 (3.72)	
[6] Diffused	4 (11.4)	6.00 (0.00)	
[7] Parietal	1 (2.9)	7.50 (3.53)	
Frontoparietal	2 (5.7)	5.74 (3.64)	

In order to compare number of PBs exhibited by participants with different levels of TBI severity, a one-way between subjects ANOVA was performed. The results are reported in Table 3. As the table demonstrates it, there was a significant difference between the number of exhibited PBs in participants with different levels of TBI severity, F (2, 32) = 7.565, P < 0.01. Performing a post hoc test using LSD with Bonferroni correction indicated that the patients with severe TBI (M = 3.00, SD = 3.22) exhibited significantly fewer number of PBs than patients with mild TBI (M = 8.00, SD = 2.73), P < 0.01. However, this study could not find any significant differences between the patients with moderate TBI (M = 6.00, SD =

3.30) with mild (P = 0.369) and severe TBI (P = 0.080) at .05 level. Moreover, this study through conducting a one-way between subject ANOVA could not find any significant difference in the number of exhibited PBs among the patients with different TBI location, F(7, 27) = 0.585, P = 0.762.

Discussion

TBI is a major cause of morbidity and mortality worldwide, including Iran.²⁶ In patients with brain injuries, pain is a key concern as it can alter cerebral perfusion and increase the risk of brain injury.²⁷ This scenario in an Iranian context reflects similar challenges that have been reported in other studies.²⁸⁻³⁰

The aim of this study was to assess the importance of behavioral pain indicators among patients with TBI who were admitted to the ICU in Amol, Iran. Patients who are admitted to ICU often experience pain, with a prevalence rate as high as 56%.³¹ This pain can happen with no intervention or be associated with routine practical care.³² The present study found support for previous research suggesting that more males suffer from TBI than females.^{23,28,33} This could be explained through gender differences. For example, males may engage in more risk-taking behaviors than females.³⁴

The most common cause of TBI in our study was attributed to motor vehicle accidents. This mechanism of injury is consistent with those of other studies and suggests that patients who exposed to high speed driving, without taking safety precautions such as helmets or seat belts are at a greater risk of injury compared to those that adopt safety measures while commuting in a motor vehicle.³⁰

To provide a suitable pain relief, sedatives and analgesics are commonly administered; however, these drugs can cause other clinical manifestations such as neurological complications.³⁵ It is therefore crucial to evaluate pain effectively in order to achieve adequate pain management without jeopardizing neurological status.³¹ Pain assessment in TBI patients admitted to ICU is a challenging task because many of them are not able to communicate effectively.⁴ Furthermore, very little evidence is currently available to guide PBs for TBI patients in ICU. The results of the present study indicate that the number of observed PBs during a pain inducing procedure was significantly greater for patients during the procedure than before or after the procedure had occurred. These findings show that painful stimuli can

cause non-verbal behaviors in TBI patients with varying levels of consciousness. On the basis of our findings, most PBs that were frequently observed during the nociceptive procedure (i.e., pressure on the nail-bed) were facial expressions, sudden eye opening, frowning, lip changes, clear movements of extremities, neck stiffness, sighing and moaning. The results of our study were in congruence with the findings of previous work.

For example; Davidson et al., found "atypical" behavioral responses among TBI patients admitted to ICUs when exposed to nociceptive procedures (i.e., turning the patient), such as flushing of the face, sudden eye opening, frowning, eye weeping, and flexion of extremities.³⁶ A possible explanation for our results may be due to the lack of some of the observed PBs, such as eye weeping and flushing which were not observed in our study.

In relation to different levels of consciousness, the results showed that these results were not statistically significant between patients who were unconscious and patients with altered levels of consciousness. However, the results demonstrated that conscious patients showed significantly different PBs than unconscious patients, and altered LOC patients. These results are slightly inconsistent with those of other studies and may suggest that PBs were documented more often in patients who were conscious and had altered levels of consciousness. However, with a small sample size, caution must be applied, as the findings cannot be generalized to other populations.

Our current findings are in contrast with those of Arbour et al., who observed that there are no significant differences between patients with different severity and location of TBI. However, Arbour et al., emphasized that eye weeping had been observed in three TBI patients with occipital lesion during nociceptive procedures.²³ A possible explanation for this might be due to the different types of nociceptive exposure applied in different studies. Eye weeping was not observed in our study.

The results of the current study showed that the number of observed PBs decreased with as the severity of TBI increased. So the patients with more severe TBI showed very few pain-related behaviors. This finding can be due to the fact that TBI causes loss of consciousness as well as affecting the patients' response to pain based on the severity of brain injury.^{37,38} The findings of this study indicate that the varying types of patients' behavioral responses differed according to the extent of TBI. To our knowledge, this finding is the first of its kind. However, previous research investigating patients with severe brain injuries have found that limited limb movements can occur following pain due to a general reduction in muscle power and response due to the loss of calponin, an essential protein responsible for soft muscle contraction. Some researchers believe that this protein may play a role in the loss of muscle response up to four hours after a TBI.²³

A number of caveats need to be noted regarding the present study. First, eye weeping and flushing of the face were not observed in our study. This may have reduced

the broader spectrum of PBs that could have been observed. Secondly, pain is a subjective experience to the individual. It is also bound to individual tolerance or threshold, gender, and cultural beliefs. Conscious patients may have different pain thresholds, especially if nociceptive stimulus was applied when the patient was aware of the stimulus. A final limitation is regarding the accuracy of the results for female participants. Females in Muslim countries, such as Iran, may have their hair and neck covered. This could have contributed to inaccurate observations of muscle stiffness among female patients.

Conclusion

Prior studies have noted the importance of effective pain assessment and understanding the complex issues that can arise for TBI adult patients in ICU. According to the findings, most behaviors observed during painful stimulus in patients with TBI included facial expressions, sudden eye opening, frowning, lip changes, clear movements of extremities, neck stiffness, and sighing or moaning. The findings of this study have implications for medical professionals in providing improved quality of care for their patients.

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Ethical issues

None to be declared.

Conflict of interest

The authors declare no conflict of interest in this study.

References

1. Ware LJ, Epps CD, Herr K, Packard A. Evaluation of the revised faces pain scale, verbal descriptor scale, numeric rating scale, and Iowa pain thermometer in older minority adults. *Pain Management Nursing* 2006; 7 (3): 117-25. doi: 10.1016/j.pmn.2006.06.005
2. Puntillo K, Pasero C, Li D, Mularski RA, Grap MJ, Erstad BL, et al. Evaluation of pain in ICU patients. *Chest* 2009; 135 (4): 1069-74. doi: 10.1378/chest.08-2369
3. Mansouri P, Javadpour S, Zand F, Ghodsbin F, Sabetian G, Masjedi M, et al. Implementation of a protocol for integrated management of pain, agitation, and delirium can improve clinical outcomes in the intensive care unit: a randomized clinical trial. *Journal of Critical Care* 2013; 28 (6): 918-22. doi:10.1016/j.jcrc.2013.06.019
4. Papakitsos G, Kapsali A, Papakitsou T. Psychometric comparison of three behavioral scales for the assessment of pain in critically ill patients unable to self-report. *Critical Care* 2015; 19 (1): P489. doi: 10.1186/cc14569
5. Lee K, Oh H, Suh Y, Seo W. Patterns and clinical correlates of pain among brain injury patients in critical care assessed with the critical care pain observation tool.

- Pain Management Nursing 2013; 14 (4): 259-67. doi: 10.1016/j.pmn.2011.05.005
6. Hajiesmaeili MR, Safari S. Pain management in the intensive care unit: do we need special protocols? *Anesthesiology and Pain Medicine* 2012; 1 (4): 237. doi: 10.5812/aapm.4523
 7. Mularski RA, White-Chu F, Overbay D, Miller L, Asch SM, Ganzini L. Measuring pain as the 5th vital sign does not improve quality of pain management. *J Gen Intern Med* 2006; 21 (6): 607-12. doi: 10.1111/j.1525-1497. 2006. 00415.x
 8. Dehghani H, Tavangar H, Ghandehari A. Validity and reliability of behavioral pain scale in patients with low level of consciousness due to head trauma hospitalized in intensive care unit. *Arch Trauma Res* 2014; 3 (1): 1-4. doi: 10.5812/atr.18608.
 9. Rijkenberg S, Stilma W, Endeman H, Bosman R, Oudemans-van Straaten H. Pain measurement in mechanically ventilated critically ill patients: behavioral pain scale versus critical-care pain observation tool. *Journal of Critical Care* 2015; 30 (1):167-72. doi:10.1016/j.jcrc.2014.09.007
 10. Alasad JA, Tabar NA, Ahmad MM. Patients' Experience of being in Intensive Care Units. *Journal of Critical Care* 2015; 30 (4): e7-11. doi: 10.1016/j.jcrc.2015.03.021
 11. Payen J-F, Bosson J-L, Chanques G, Mantz J, Labarere J. Pain assessment is associated with decreased duration of mechanical ventilation in the intensive care unit. *Anesthesiology* 2009; 111 (6): 1308-16.
 12. Payen J-F, Gélinas C. Measuring pain in non-verbal critically ill patients: which pain instrument? *Critical Care* 2014; 18 (54). doi: 10.1186/s13054-014-0554-5
 13. Gélinas C. Pain assessment in the critically ill adult: Recent evidence and new trends. *Intensive and Critical Care Nursing* 2016; 34: 1-11. doi: 10.1016/j.iccn.2016.03.001.
 14. Gholami B, Haddad M, Tannenbaum AR. Agitation and pain assessment using digital imaging. *Engineering in medicine and biology society, 2009. United State: EMBC 31st Annual International Conference of the IEEE; 2009. doi: 10.1109/IEMBS.2009.5332437*
 15. Gélinas C, Arbour C. Behavioral and physiologic indicators during a nociceptive procedure in conscious and unconscious mechanically ventilated adults: similar or different? *Journal of Critical Care* 2009; 24 (4): 628. 628.e7-628.e17. doi: 10.1016/j.jcrc. 2009.01.013.
 16. Gélinas C, Arbour C, Michaud C, Vaillant F, Desjardins S. Implementation of the critical-care pain observation tool on pain assessment/management nursing practices in an intensive care unit with nonverbal critically ill adults: a before and after study. *Int J Nurs Stud* 2011; 48 (12): 1495-504. doi:10.1016/j.ijnurstu.2011.03.012
 17. Craig KD. The facial expression of pain Better than a thousand words? *APS Journal* 1992;1 (3): 153-62.
 18. Cade CH. Clinical tools for the assessment of pain in sedated critically ill adults. *Nursing in Critical Care*. 2008; 13 (6): 288-97. doi:10.1111/j.1478-5153.2008.00294.x
 19. Bucknall T, Manias E, Botti M. Nurses' reassessment of postoperative pain after analgesic administration. *Clin J Pain* 2007; 23 (1): 1-7.
 20. Shannon K, Bucknall T. Pain assessment in critical care: what have we learnt from research. *Intensive and Critical Care Nursing* 2003; 19 (3): 154-62. doi:10.1016/S0964-3397(03) 00027-2
 21. Gordon DB, Rees SM, McCausland MP, Pellino TA, Sanford-Ring S, Smith-Helmenstine J, et al. Improving reassessment and documentation of pain management. *Jt Comm J Qual Saf* 2008; 34 (9): 509-17. doi:1016/S1553-7250(08)34065-3
 22. Wells N, Pasero C, McCaffery M. Improving the quality of care through pain assessment and management. *Patient safety and quality: an evidence-based handbook for nurses*. 1st ed. Rockville: Agency for Healthcare Research and Quality (US); 2008.
 23. Arbour C, Choiniere M, Topolovec-Vranic J, Loisel CG, Puntillo K, Gelinac C. Detecting pain in traumatic brain-injured patients with different levels of consciousness during common procedures in the ICU: typical or atypical behaviors? *The Clinical Journal of Pain* 2014; 30 (11): 960-9. doi: 10.1097 /AJP.0000000000000061.
 24. Kotfis K, Zegan-Barańska M, Szydłowski Ł, Żukowski M, Ely WE. Methods of pain assessment in adult intensive care unit patients—polish version of the CPOT (Critical care pain observation tool) and BPS (behavioral pain scale). *Anesthesiology Intensive Therapy* 2017; 49 (1): 66-72. doi: 10.5603/AIT.2017.0010.
 25. Puntillo KA, Morris AB, Thompson CL, Stanik-Hutt J, White CA, Wild LR. Pain behaviors observed during six common procedures: results from Thunder Project II. *Critical Care Medicine* 2004; 32 (2): 421-7. doi: 10.1097 /01. CCM.0000108875.35298.D2
 26. Nazari R, Bijani A, Haji Hosseini F, Beheshti Z, Sharif Nia H, Hojati H. Mortality and injury severity in the accident victims referred to the hefdah shahrivar hospital of Amol 2007. *Journal of Babol University of Medical Sciences* 2011; 13 (1): 76-81. (Persian)
 27. Payen J-F, Francony G, Canet C, Coppo F, Fauvage B, editors. *Neurosédation en réanimation. Annales Francaises d'anesthésie et de Reanimation* 2009; 28 (12): 1015-19. doi:10.1016/j.annfar.2009.10.003.
 28. Vafae R, Vafaei A, Forouzanfar MM, Asadollahi S, Kashani P, Heidari K, et al. Epidemiology of traumatic brain injury in Iranian population: the results of a multicenter study. *Wulfenia* 2013; 20 (9): 257-63.
 29. El-Matbouly M, El-Menyar A, Al-Thani H, Tuma M, El-Hennawy H, AbdulRahman H, et al. Traumatic brain injury in qatar: age matters—insights from a 4-year observational study. *Scientific World Journal* 2013: 354920. doi:10.1155/2013/354920.
 30. Monsef Kasmaei V, Asadi P, Zohrevandi B, Raouf MT. An epidemiologic study of traumatic brain injuries in emergency department. *Emergency* 2015; 3 (4): 141-5.
 31. Roulin MJ, Ramelet AS. Behavioral changes in brain-injured critical care adults with different levels of consciousness during nociceptive stimulation: an observational study. *Intensive Care Medicine* 2014; 40 (8): 1115-23. doi:10.1007/s00134-014-3380-y
 32. Latorre-Marco I, Solís-Muñoz M, Acevedo-Nuevo M, Hernández-Sánchez ML, López-López C, Sánchez-Sánchez MdM, et al. Validation of the behavioural indicators of pain scale ESCID for pain assessment in non-communicative and mechanically ventilated critically ill patients: a research protocol. *Journal of Advanced Nursing* 2015; 72 (1): 205-16. doi:10.1111/jan.12808.
 33. Fakharian E, Mohammadzadeh M, Behdadmehr S, Sabri HR, Mirzadeh AS, Mohammadzadeh J. Repetitive traumatic brain injury in patients from Kashan, Iran. *Trauma Mon* 2016; 21 (4):1-6. doi: 10.5812 /traumamon. 23869.
 34. Fuertes JN, Grindell SR, Kestenbaum M, Gorman B. Sex, parent attachment, emotional adjustment, and risk-taking

- behaviors. *Int J High Risk Behav Addict* 2017; 6 (2). doi: 10.5812/ijhrba.36301.
35. Gottschalk A, Yaster M. The perioperative management of pain from intracranial surgery. *Neurocritical Care* 2009; 10 (3): 387-402. doi: 10.1007/s12028-008-9150-3.
36. Davidson JE, Winkelman C, Gélinas C, Dermenchyan A. Pain, agitation, and delirium guidelines: nurses' involvement in development and implementation. *Critical Care Nurse* 2015; 35 (3): 17-31. doi: 10.4037/ccn2015824.
37. Lemke DM. Sympathetic storming after severe traumatic brain injury. *Critical Care Nurse* 2007; 27 (1): 30-7.
38. Young JA. Pain and traumatic brain injury. *Physical Medicine and Rehabilitation Clinics* 2007; 18 (1): 145-63. doi:10.1016/j.pmr.2006.11.008.